

From End-of-Life Aerospace CFRP Composites to Activated Carbon: Enabling Sustainable Aviation through High-Value Composite Recycling

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Abstract

The extensive adoption of carbon fibre reinforced polymer (CFRP) composites in modern aircraft has significantly increased the generation of manufacturing and end-of-life composite waste, creating an emerging sustainability challenge for the aerospace industry. CFRP constitutes approximately 50 wt.% of the Boeing 787 and 53 wt.% of the Airbus A350 airframe, while manufacturing operations generate nearly 10–30% composite scrap. This study evaluates the conversion of aerospace CFRP waste into activated carbon as a high-value upcycling strategy supporting circular aviation. Current carbonization and activation technologies, including pyrolysis, steam/ CO_2 activation and chemical activation, are critically examined regarding carbon recovery, pore development, environmental impact and technological readiness. Reported studies demonstrate that activated carbons derived from recovered CFRP can achieve Brunauer–Emmett–Teller surface areas exceeding $800 \text{ m}^2\text{g}^{-1}$, providing excellent adsorption capability for volatile organic compounds, ozone and other airborne contaminants. Considering projections that global CFRP waste may exceed 500,000 tonnes annually by 2050, transforming this secondary carbon resource into activated carbon could simultaneously reduce composite waste disposal, decrease dependence on virgin carbon precursors and support sustainable adsorption materials for aircraft cabin air purification, environmental control systems and maintenance-related filtration. Unlike conventional recycling approaches, this study establishes a conceptual framework for returning carbon recovered from end-of-life aerospace composites back into aviation applications, thereby enabling a closed-loop carbon cycle for the aerospace sector.

Keywords

Carbon fibre reinforced polymer (CFRP), Activated carbon, Circular economy, Aerospace recycling, Sustainable aviation.